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Antonio De Angeli*, Alessandro Garassino** & Giovanni Pasini***

New reports of anomurans and brachyurans from the Cenozoic of Tuscany (Italy)

Abstract – Anomurans and brachyurans from Tuscany have previously been reported by Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897), and Delle Cave (1988a, b). The recent discovery of new anomurans and brachyurans from some localities in Pisa, Livorno, Siena, and Grosseto provinces increases the carcinologic knowledge from the Cenozoic of Italy. The infraorder Anomura H. Milne Edwards, 1832, includes *Callianassa* cfr. *C. subterranea* (Montagu, 1808) and *C. chalmasii* Brocchi, 1882 (Callianassidae Dana, 1852); *Dardanus substriatus* (A. Milne Edwards, 1861) (Diogenidae Ortmann, 1892). The infraorder Brachyura Latreille, 1802, includes *Lysirude paronae* (Crema, 1895) and *Raninoides pliocenicus* n. sp. (Raninidae De Haan, 1839); *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004 (Dorippidae MacLeay, 1838); *Ethusa popogniensis* n. sp. (Ethusidae Guinot, 1977); *Calappa granulata* (Linnaeus, 1758) (Calappidae H. Milne Edwards, 1837); *Ebalia* cfr. *E. deshayesi* Lucas, 1846, *E. cranchii* Leach, 1817, *E. fucinii* Ristori, 1892, *Ilia pliocenica* Ristori, 1891, and *Palaeomyra bispinosa* A. Milne Edwards, 1861 (Leucosiidae Samouelle, 1819); *Liocarcinus* sp. (Portunidae Rafinesque, 1815); *Monodaeus bortolottii* Delle Cave, 1988 (Xanthidae MacLeay, 1838); *Pilumnus ristorii* new replacement name for *P. spinosus* Ristori, 1886 (Pilumnidae Samouelle, 1819); *Eriphia cocchii* Ristori, 1886 (Eriphiidae MacLeay, 1838); *Goneplax gulderi* Bachmayer, 1953 (Goneplacidae MacLeay, 1838); *Astenognathus* sp. (Varunidae H. Milne Edwards, 1853). The discovery of *Raninoides* H. Milne Edwards, 1837, is very important because it represents the first report of this genus in the Pliocene of Europe.

Key words: Crustacea, Decapoda, Cenozoic, Tuscany, Italy.

Riassunto – Nuova segnalazione di anomuri e brachiuri nel Cenozoico della Toscana (Italia).

Gli anomuri e i brachiuri della Toscana sono stati precedentemente segnalati da Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897) e Delle Cave (1988a, b). La recente scoperta di nuovi anomuri e brachiuri in alcune località delle province di Pisa, Livorno, Siena e Grosseto incrementa le conoscenze carcinologiche per il Cenozoico d'Italia. L'infraordine Anomura H. Milne Edwards, 1832 comprende *Callianassa* cfr. *C. subterranea* (Montagu, 1808) e *C. chalmasii* Brocchi, 1882 (Callianassidae Dana, 1852); *Dardanus substriatus* (A. Milne Edwards, 1861) (Diogenidae Ortmann, 1892). L'infraordine Brachyura Latreille, 1802 comprende *Lysirude paronae* (Crema, 1895) e *Raninoides pliocenicus* n. sp. (Raninidae De Haan, 1839); *Medorippe ampla*

* Piazzetta Nostro Tetto 9, 36100 Vicenza, Italy; Associazione Amici del Museo "G. Zannato", Piazza Marconi 15, 36075 Montecchio Maggiore (Vicenza), Italy, e-mail: antonio.deangeli@alice.it

** Museo di Storia Naturale di Milano, Corso Venezia 55, 20121 Milano, Italy, e-mail: agarassino63@gmail.com

*** Museo Civico dei Fossili di Besano, Via Prestini 5, 21050 Besano (Varese), Italy, e-mail: juanaldopasini@tiscali.it

Garassino, De Angeli, Gallo & Pasini, 2004 (Dorippidae MacLeay, 1838); *Ethusa popoguensis* n. sp. (Ethusidae Guinot, 1977); *Calappa granulata* (Linnaeus, 1758) (Calappidae H. Milne Edwards, 1837); *Ebalia* cfr. *E. deshayesi* Lucas, 1846, *E. cranchii* Leach, 1817, *E. fucinii* Ristori, 1892, *Ilia pliocenica* Ristori, 1891 e *Palaeomyra bispinosa* A. Milne Edwards, 1861 (Leucosiidae Samouelle, 1819); *Liocarcinus* sp. (Portunidae Rafinesque, 1815); *Monodaeus bortolottii* Delle Cave, 1988 (Xanthidae MacLeay, 1838); *Pilumnus ristorii* nuovo nome per *P. spinosus* Ristori, 1886 (Pilumnidae Samouelle, 1819); *Eriphia cocchii* Ristori, 1886 (Eriphiidae MacLeay, 1838); *Goneplax gulderi* Bachmayer, 1953 (Goneplacidae MacLeay, 1838); *Asteognathus* sp. (Varunidae H. Milne Edwards, 1853). La scoperta di *Raninoides* H. Milne Edwards, 1837 è molto importante in quanto rappresenta la prima segnalazione di questo genere nel Pliocene europeo.

Parole chiave: Crustacea, Decapoda, Cenozoico, Toscana, Italia.

Introduction and geological setting

The anomurans and brachyurans from the Cenozoic of Tuscany have been the subject of study by Cappellini (1874), Fucini (1910), Ristori (1886, 1888, 1891, 1892, 1896), Vinassa de Regny (1897), and Delle Cave (1988a, b) who reported the presence of these decapods from Firenze, Pisa, Livorno, and Siena provinces (see Garassino & De Angeli, 2004; De Angeli & Garassino, 2006a and Appendix).

The recent discovery of anomurans and brachyurans from some new localities or previously reported localities with incorrect or generalised place-names, such as Parrana San Giusto, Rio Popogna (Livorno), Presciano (Siena), Monterotondo Marittimo (Grosseto) and from some already known localities, such as Balconevisi (Pisa), Pietrafitta, Ciuciano, La Strolla, Poggio alla Staffa, Cava I Sodi, and Terre Rosse (Siena), (Fig. 1), allowed to increase the carcinologic knowledge about these groups during the Mio-Pliocene and Lower Pleistocene evolution of the Tuscany basin (Bossio *et al.*, 1993).

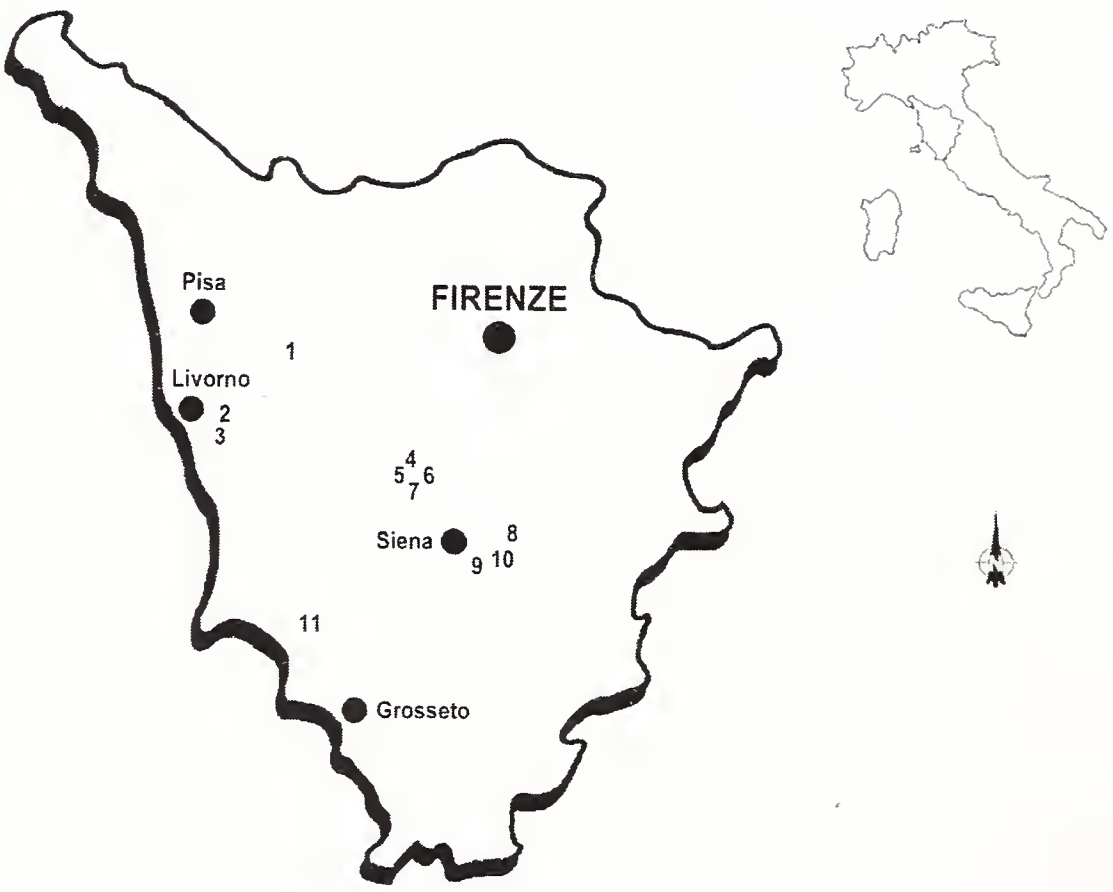

Fig. 1 – Tuscany Region with the new fossiliferous localities. / Regione Toscana con le nuove località fossilifere. 1) Balconevisi. 2) Parrana San Giusto. 3) Rio Popogna. 4) Pietrafitta. 5) Ciuciano. 6) La Strolla. 7) Poggio alla Staffa. 8) Presciano. 9) Cava I Sodi. 10) Terre Rosse. 11) Monterotondo Marittimo.

Balconevisi

The small village of Balconevisi is located on the top of a hill, 6 km S of San Miniato municipality (Pisa), on the left flank of the southern Val d'Elsa River Basin (Parona, 1903). The studied specimens (MSNM i27214, GPDG 0065) were discovered in bluish clays from the Lower Pliocene (Piacentian) (Dominici *et al.*, 1997; Carta Geol. Toscana 1:250.000, UniSiena 2004).

Parrana San Giusto

Parrana San Giusto (Livorno) is located about 4 km N of Gabbro village, in the Livornesi Mounts. The studied specimens (GPDG 0076, 0089) were discovered in sandy deposits (grey sands). These sediments are dated as Pliocene (Carta Geol. Toscana, foglio 284, Rosignano Marittimo; 1:25.000), but also, in the upper part, as Pleistocene for the malacofauna (Forli, pers. comm., 2008). The studied specimens, without relaiable stratigraphic data, have been ascribed generically to the Plio-Pleistocene (Bossio *et al.*, 1981; Cauli, 1981).

Rio Popogna

Rio Popogna, located W of Gabbro village (Livorno), close to Livornesi Mounts (De Stefani, 1911), exposes, along its upper course, a limited and discontinuous series of fossiliferous marine deposits (30 m long) of marly clays from the Tortonian (Miocene) (Parona, 1903) and sandy clays from the lower Messinian (Miocene) (Trentanove, 1901; Carta Geol. Toscana, foglio 284, Rosignano Marittimo; 1:25.000). The studied specimens (GPDG 0051-0061, 0070-0072, 0085-0087; MSNM i27082-i27087) come from small sized blocks of eroded sediment, enclosing a rich and well diversified carcinologic fauna, strongly compressed irregular echinoids (spatangids), gastropods, bivalves and rare fragments of terrestrial plants. The crustaceans are usually disarticulated, testifying to transport *post mortem* and they are distributed in different clay-marly levels of the exposed series, 1.70 m thick.

Pietrafitta

This locality, known for the rich malacofauna, is located behind San Gimignano and Poggibonsi municipality (Siena), including two localities, close to each other, called "Vigna" and "Villa". The studied specimens (GPDG 0077, 0078, 0082, 0083; MSNM i27215) were collected in yellow sands from the Lower Pliocene (Pantanelli, 1880; Carta Geol. Toscana, 1:10.000).

Ciuciano

The studied specimens (GPDG 0079, 0080) were discovered in this locality, located in San Gimignano municipality (Siena), and known for its sands and grey clays, rich in marine invertebrates from the Lower Pliocene (Zanclean – Piacentian) (Forli & Dell'Angelo, 2000).

La Strolla

A wide quarry, La Strolla, located about 4 km S of Poggibonsi (Siena) (Carta Geol. Toscana, foglio 286, Poggibonsi; 1:100.000), is known for the richness and variety of its fossils (Fioravanti *et al.*, 2000). The basal deposits are composed of gravels and sands from the lower Messinian (Miocene), covered by green clays from the upper Messinian. Gray clays from the Lower Pliocene and sands from the

Middle-Upper Pliocene are present at the top of the series (Brunetti, 2002). The studied specimen (GPDG 0081), without stratigraphic reference, comes from the upper sandy levels, dated as Pliocene *sensu lato*.

Poggio alla Staffa

The studied specimen (GPDG 0075) was discovered in the locality Podere Melograni-Poggio alla Staffa, close to Colle Val d'Elsa (Siena) where marine sands and grey clays of littoral environment from the Lower Pliocene (Piacentian - Zanclean) crop out (Brunetti & Della Bella, 2003; Carta Geologica Toscana, 1:10.000).

Presciano

The studied specimen (GPDG 0073) was discovered close to Taverne d'Arbia village, at Presciano, located E of Siena. The sedimentary series includes yellow sandy facies from the Lower-Middle Pliocene (Carta Geol. d'Italia, IGM, foglio 121, Montepulciano; 1:100000, Ist. Poligrafico di Stato, Ercolano, NA, 1960). Therefore, the specimen has been ascribed generically to the Pliocene.

Cava I Sodi

The studied specimen (GPDG 0066) was discovered in a quarry, close to Castelnuovo Berardenga-Scalo, located E of Siena. This quarry shows deposits of clays and sandy clays from the Lower-Middle Pliocene (Carta Geol. d'Italia, IGM, foglio 121, Montepulciano; 1:100000, Ist. Poligrafico di Stato, Ercolano, NA, 1960), already known for the rich malacofauna and fossil vertebrates (Bogi *et al.*, 2002; Manganelli & Spadini, 2001, 2003). We ascribed the specimen generically to the Pliocene *sensu lato* because of the absence of chronostratigraphic data.

Terre Rosse

The studied specimens (GPDG 0062-0064, 0069, 0074, 0084) were discovered in Terre Rosse, N of Rapolano Terme (Siena), that includes two localities close to each other (Stroncoli e Campino) where sands of littoral origin from the Lower Pliocene (Piacentian) preserve marine vertebrates and invertebrates (Laghi, 1984; Manganelli *et al.*, 2003; Forli *et al.*, 2004) (Carta IGM, 1:25.000, Foglio 297, sez. I, 1994).

Monterotondo Marittimo

Monterotondo Marittimo is located in Grosseto province close to the Metalliferi Mounts. The sediments of a small abandoned quarry, located SW of Monterotondo Marittimo, undergo a washing away, producing the exposure of the studied specimens (GPDG 0067, 0068, 0088; CF-TCR 1, 2; IGF 13314E, 14636E, 14637E). Moreover, fragments of a juvenile misticete were discovered in this quarry (Casati, pers. comm., 2007). The studied specimens, discovered in grey poorly fossiliferous clays, are usually associated with rare small-sized bivalves and irregular echinoids, that are strongly compressed (*Schizaster*? Pasini, pers. comm., 2007). Indeterminate bits of organic materials are also present. The kind of deposition and its discontinuity could indicate an environment of chaotic sedimentation in the presence of more or less wide submarine conoids. The marly marine deposits of the studied area are dated to the Lower-Middle Pliocene (Carta Geol. d'Italia., foglio 119, Massa Marittima, 1:100000). We ascribed the studied specimens to the Pliocene *sensu lato* because of the absence of chronostratigraphic data (Bisconti, pers. comm., 2007).

Material

The studied sample includes 51 specimens of anomurans and brachyurans. We identified some specimens as belonging to species already known in Italy, and others as belonging to new species. Almost all specimens are preserved three-dimensionally and their preparation was easy as a result of the softness of surrounding clays and sands. Some specimens come from washing and sieving of sediments.

The infraorder Anomura H. Milne Edwards, 1832, includes *Callianassa* cfr. *C. subterranea* (Montagu, 1808) (11 specimens), *C. chalmasii* Brocchi, 1882 (2 specimens) and *Dardanus substriatus* (A. Milne Edwards, 1861) (2 specimens).

The infraorder Brachyura Latreille, 1802, includes *Lysirude paronae* (Crema, 1895) (1 specimen), *Raninoides pliocenicus* n. sp. (4 specimens), *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004 (2 specimens), *Ethusa popognensis* n. sp. (1 specimen), *Calappa granulata* (Linnaeus, 1758) (2 specimens), *Ebalia* cfr. *E. deshayesi* Lucas, 1846 (1 specimen), *E. cranchii* Leach, 1817 (1 specimen), *E. fucinii* Ristori, 1892 (1 specimen), *Pilumnus ristorii* new replacement name for *P. spinosus* Ristori, 1886 (1 specimen), *Monodaeus bortolottii* Delle Cave, 1988 (1 specimen), *Ilia pliocenica* Ristori, 1891 (4 specimens), *Palaeomyra bispinosa* A. Milne Edwards, 1861 (1 specimen), *Liocarcinus* sp. (2 specimens), *Eriphia cocchii* Ristori, 1886 (3 specimens), *Goneplax gulderi* Bachmayer, 1953 (11 specimens), *Astenognathus* sp. (1 specimen).

The studied sample is housed in the Palaeontological Collections of the Museo Gruppo Paleontologico "C. De Giuli", (Castelfiorentino - Firenze), housed in the Biblioteca Comunale Vallesiana (GPDG), Centro Civico "Ofelia Mangini", seat of Gruppo GAMPS (Badia a Settimo, Scandicci – Firenze) (CF-TCR), Museo di Storia Naturale dell'Università degli Studi di Firenze (IGF), and in the Museo di Storia Naturale di Milano (MSNM). Some incomplete specimens, ascribed tentatively to *Raninoides* sp. are housed in the Università di Firenze (Casati, pers. comm., 2007).

The sizes of the specimens are expressed in millimetres.

The systematic arrangement used in this paper follows the recent classification proposed by Martin & Davis (2001) and Ng *et al.* (2008).

Abbreviations

lcxp = lenght of carapace
wcxp = width of carapace
wf = width of front
wo-f = width of orbito-frontal margin
lp = length of palm (excluded fixed finger)
h = height of palm
tp = thickness of palm
lt = length of propodus (with fixed finger)
lff = lenght of fixed finger
lmf = lenght of movable finger

Systematic Palaeontology

Infraorder Thalassinidea Latreille, 1831
Superfamily Callianassoidea Dana, 1852
Family Callianassidae Dana, 1852
Genus *Callianassa* Leach, 1814

Type species: *Cancer* (*Astacus*) *subterraneus* Montagu, 1808.

Callianassa cfr. *C. subterranea* (Montagu, 1808)
Fig. 2 A-B

Stratigraphic range: Upper Miocene (Messinian).
Type locality: Rio Popogna (Livorno).
Material and measurements: six left propodi (GPDG 0051, 0052, 0056, 0058, 0059, 0060) and five right propodi (GPDG 0053, 0054, 0055, 0057, 0061); two specimens (GPDG 0051, 0052) with propodus and merus.
GPDG 0051 – lt: --; lp: 7.8; h: 7.6
GPDG 0052 – lt: 14.6; lp: 7.7; h: 8.3
GPDG 0053 – lt: 7; lp: 4; h: 4
GPDG 0054 – lt: 8; lp: 4.5; h: 4.7
GPDG 0055 – lt: 13.3; lp: 6,5; h: 6.7
GPDG 0056 – lt: 8.7; lp: 5.1; h: 5
GPDG 0057 – lt: 142.2; lp: 5.9; h: 6.5
GPDG 0058 – lt: 9; lp: 5.3; h: 5
GPDG 0059 – lt: 7.7; lp: 4.6; h: 4.8
GPDG 0060 – lt: 13.3; lp: 7.8; h: 7
GPDG 0061 – lt: 8.4; lp: 4.8; h: 4.8
Description. Merus as long as high, with straight upper margin and convex lower margin. Propodus with palm longer than high. Upper and lower margins almost straight and divergent. Lower margin with dentate ridge. Outer surface slightly raised and smooth. Elongate fixed finger, strongly narrow and curved distally. Occlusal margin smooth and without teeth. Outer surface with longitudinal ridge and some orifices. Movable finger longer than fixed finger. Upper margin almost straight and convex only distally.
Discussion. The studied specimens have close morphological affinities with the Recent *Callianassa subterranea* (Montagu, 1808), widespread in the Eastern Atlantic Ocean and in the Mediterranean Sea with smaller specimens living in deeper waters (35-500 m) (Ngoc-Ho, 2003). This species has been also described in the fossil record from the Helvetian (Middle Miocene) of Albugnano (Piemonte) and from the Miocene of Sardegna (Crema, 1895; Lőrenthey, 1909). Moreover Ristori (1889) recorded *Callianassa subterranea* var. *dentata* from the Miocene-Pleistocene of Piemonte, Lazio, Puglia, and Sicilia. The studied specimens show, respect *C. subterranea*, margins of palm more inclined, fixed finger thinner and curved proximally, and movable finger more rectilinear.

Callianassa chalmasii Brocchi, 1883
Fig. 2 C-D

1883 – *Callianassa chalmasii* Brocchi; p. 6, 7, Pl. 5 (figs. 7, 8)
1898 – *Callianassa chalmasii* Brocchi *in* Lőrenthey; p. 93, 105, 114
1929 – *Callianassa chalmasii* Brocchi *in* Lőrenthey & Beurlen; p. 33, 65, Pl. 2 (figs. 15 a, b)
1961 – *Callianassa espichelensis* Veiga Ferreira; p. 478, Pl. 1 (figs. 1-11)
1979 – *Callianassa chalmasii* Brocchi *in* Müller; p. 274, Pl. 1 (fig. 5)
1984 – *Callianassa chalmasii* Brocchi *in* Müller; p. 50, Pl. 2 (figs. 3-7)

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena).
Material and measurements: two propodi, one right and one left.
GPDG 0062 – lt: 15; lp: 12.2; h: 11.5; tp: 4.7
GPDG 0063 – preserved palm, not measurable

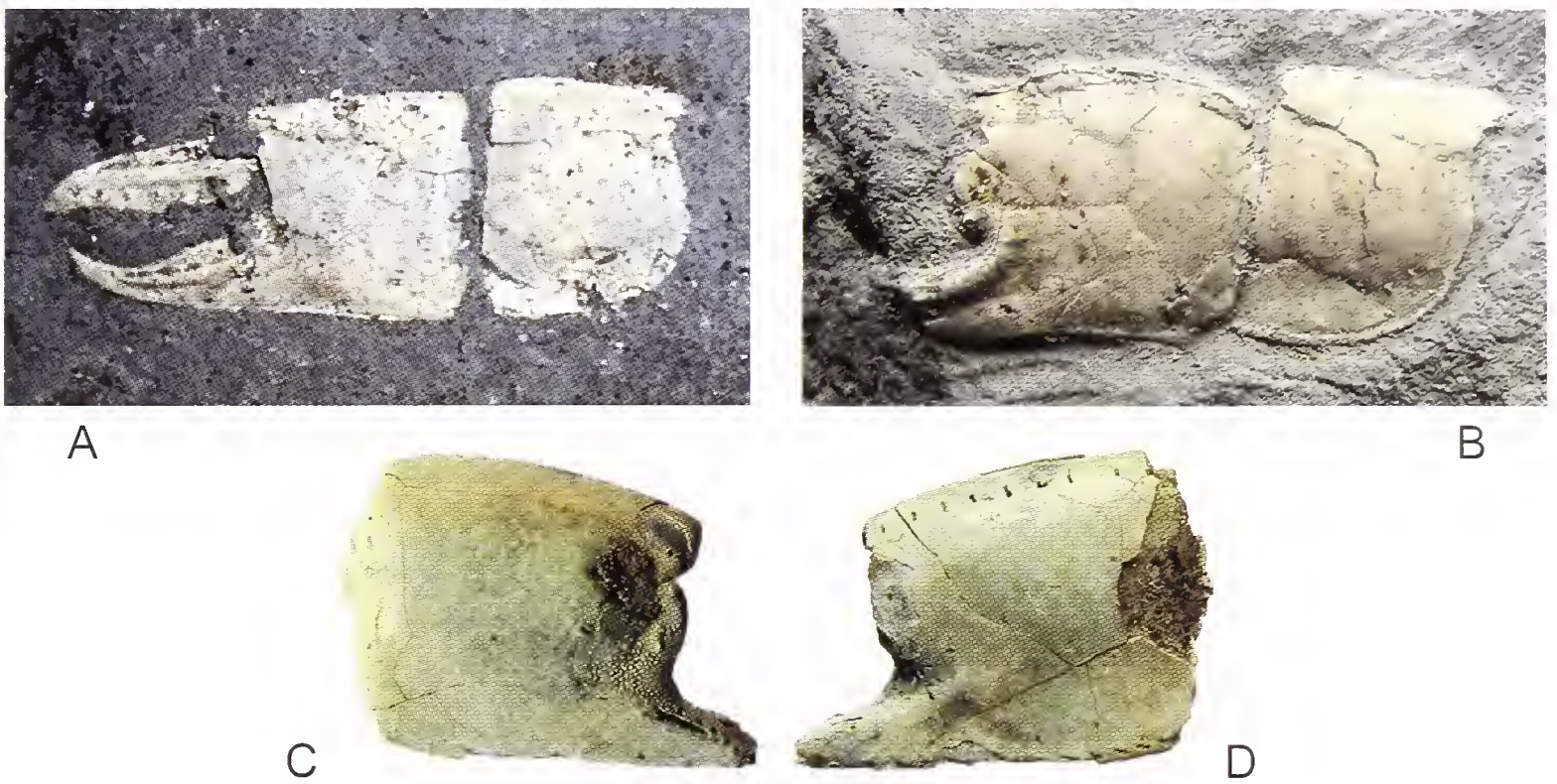

Fig. 2 – A) *Callianassa* cfr. *subterranea* (Montagu, 1808), GPDG0052, left cheliped/chelipede sinistro (x 2.2); B) *Callianassa* cfr. *subterranea* (Montagu, 1808), GPDG0051, left cheliped/chelipede sinistro (x 2.8). C, D) *Callianassa chalmasii* (Brocchi, 1883), GPDG0062, right propod/propodus destro. C) outer view/norma esterna. D) inner view/norma interna (x 1.5).

Discussion. The studied specimens have a short carpus, raised on outer surface and with lower margin strongly convex. Subsquare palm, as long as high. Upper margin slightly convex, lower margin straight and ridged externally. Outer surface convex and smooth. Small granulations are located in the median part of palm, close to the fixed finger. Inner surface almost flat. Nine oval pits are present in the upper part, some orifices are present in the lower part, along the margin. Fixed figer poorly developed with one tooth on occlusal margin.

The studied propodi show morphological affinities with *Callianassa chalmasii* Brocchi, 1883, described from the Miocene (middle Badenian) of Hungary and recorded also from the Miocene (Tortonian) of Portugal (Veiga Ferreira, 1961; Müller, 1984a). Peculiar characters are the presence of one short fixed finger with one tooth on occlusal margin and aligned pits located on the upper part of inner surface of palm. Therefore the studied specimens represent a probable spread of this species also in the Pliocene.

Superfamily Paguroidea Latreille, 1802
Family Diogenidae Ortmann, 1892
Genus *Dardanus* Paulson, 1875

Type species: *Dardanus hellerii* Paulson, 1875.

Dardanus substriatus (A. Milne Edwards, 1861)
Fig. 3 A-B

1846 – *Pagurus striatus* Latreille *in* E. Sismonda; p. 70, Pl. 3 (fig. 8)
1861 – *Pagurus substriatus* A. Milne Edwards *in* E. Sismonda; p. 20
1886 – *Pagurus substriatus* A. Milne Edwards *in* Ristori; p. 124, Pl. 3 (figs. 14, 15)
1929 – *Pagurus substriatus* A. Milne Edwards *in* Glaessner; p. 288
2006 – *Pagurus substriatus* A. Milne Edwards *in* De Angeli & Garassino, p. 27

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena) and Balconevisi (San Miniato – Pisa).
Material and measurements: one movable finger of left cheliped (GPDG 0064 from Terre Rosse: lmf: 14) and one right palm (GPDG 0065 from Balconevisi: lp: 14.6; h: 13.5; tp: 9.7).

Discussion. Palm longer than high, with upper and lower margins convex. Outer surface raised and totally covered with granulate transverse and sinuous ridges having many pores. Inner surface slightly convex with the same ornamentation of the outer surface. Fixed finger, incomplete distally, short and with two rows of tubercles separated by a smooth line. Movable finger having scaly sinuous course. The ridge is serrate because of the presence of small tubercles having apices with a small orifice. This species has been recorded by A. Milne Edwards (1861), E. Sismonda (1846, 1861), and Ristori (1886) from the Pliocene of Asti (Piemonte) and Volterra (Toscana). A. Milne Edwards (1861) compared *Pagurus substriatus* with the Recent *P. striatus* Latreille, 1803. *Pagurus striatus* is considered as synonymous of *Dardanus arrosor* (Herbst, 1796). Therefore the species described by A. Milne Edwards must be ascribed to *Dardanus* Paulson, 1875.

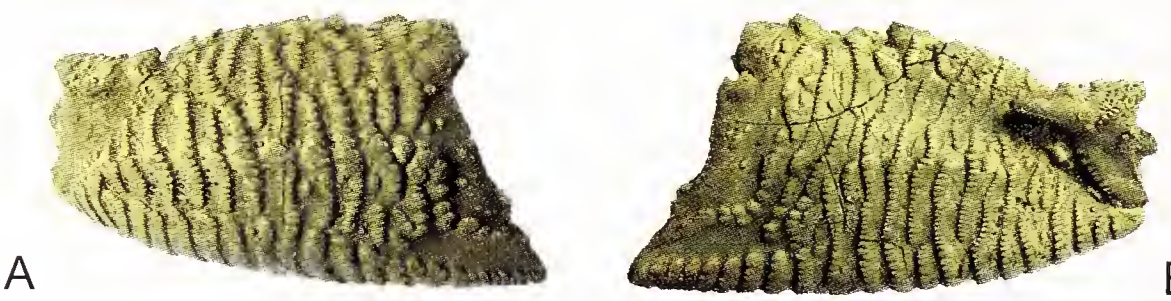

Fig. 3 – *Dardanus substriatus* (A. Milne Edwards, 1861), GPDG 0065, right propod/propodus destro. A) outer view/norma esterna. B) inner view/norma interna (x 1.5).

Infraorder Brachyura Linnaeus, 1758
Section Podotremata Guinot, 1977
Subsection Archaeobrachyura Guinot, 1977
Superfamily Raninoidea De Haan, 1839
Family Raninidae De Haan, 1839
Genus *Lysirude* Goeke, 1985

Type species: *Raninoides nitidus* A. Milne Edwards, 1880.

Lysirude paronae (Crema, 1895)
Fig. 4

1895 – *Lyreidus paronae* Crema; p. 671, Text-fig. 11
1907 – *Lyreidus paronae* Crema *in* Sacco ; p. 116
1929 – *Lyreidus paronae* Crema *in* Glaessner; p. 241
1998 – *Lysirude paronae* (Crema) *in* Tucker; p. 324
2004 – *Lysirude paronae* (Crema) *in* Garassino, De Angeli, Gallo & Pasini; p. 258, Text-figs. 3-4
2006 – *Lysirude paronae* (Crema) *in* De Angeli & Garassino; p. 36

Stratigraphic range: Pliocene *sensu lato*.
Type locality: Cava I Sodi, Castelnuovo Berardenga-Scalo (Siena).
Material and measurements: one complete specimen.

GPDG 0066 – lcxp: 23.7; wcxp: 15.8; wo-f: 6.8.

Discussion. The studied specimen has the narrow orbito-frontal margin with one strong extraorbital spine on both margins of rostrum and the presence of one spine on both anterolateral margins. These characters allow assignment of the studied specimen to *Lysirude paronae* (Crema, 1895) from the Helvetian (Miocene) of Sciolze and from the Langhian (Miocene) of S. Margherita (Torino). This species has been recently described also from the Pliocene of Orta San Giulio (Novara, Piemonte) (Garassino *et al.*, 2004).

Fig. 4 – *Lysirude paronae* (Crema, 1895), GPDG 0066 (x 2.5).

Genus *Raninoides* H. Milne Edwards, 1837

Type species: *Ranina laevis* Latreille, 1825.

Raninoides pliocenicus n. sp.
Fig. 5 A-D

Diagnosis: carapace convex transversely, longer than wide; triangular rostrum; supraorbital margins with three teeth and two fissures; anterolateral margins convex with one spine; dorsal regions not distinct; anterior part of the dorsal surface with one granulate postfrontal ridge; dorsal surface slightly dotted.

Etymology: the trivial name alludes to the Pliocene, geological age of the studied specimens.

Holotype: GPDG 0068.

Paratypes: GPDG 0067, CF-TCR1.

Stratigraphic range: Pliocene *sensu lato*.

Type locality: Monterotondo Marittimo (Grosseto).

Material and measurements: four complete specimens in dorsal view, from 15 to 30 mm long. GPDG 0067, 0068, CF-TCR 1, IGF 13314E (counter-part).

GPDG 0067 – lcxp: 23.3; wcxp: 13.4; wo-f: 10.4

GPDG 0068 – lcxp: 14.5; wcxp: 9; wo-f: 6.5

CF-TCR1 – lcxp: 28.4; wcxp: 17.2; wo-f: 12

IGF 13314E – lcxp: 15; wcxp: 9; wo-f: 7

Description: carapace convex transversely, longer than wide (width 0.60 maximum length of carapace, rostrum included). Orbito-frontal margin occupies the entire anterior part of carapace (orbito-frontal margin about 0.74 of the maximum width of carapace). Rostrum elongate, subtriangular with rounded tip. Short preorbital tooth. Wide supraorbital margin marked by two deep oblique fissures. Supraorbital tooth narrower, but longer than preorbital and extraorbital teeth. Supraorbital tooth with triangular tip. Extraorbital tooth wider than previous elongated forwards with one spine. Diverging antero-lateral margins with one oblique spine. Converging postero-lateral margins with one granulate ridge. Posterior margin narrower than orbito-frontal margin and slightly convex. Dorsal regions not distinct. One granulate post-frontal ridge, convex anteriorly, is located among antero-lateral spines. Dorsal surface with irregular pits.

Discussion. The morphological characters, peculiar of the species belonging to *Raninoides* H. Milne Edwards, 1837, and *Laeviranina* Lőrenthey & Beurlen, 1929, are very similar, making difficult their true systematic validity. In fact Feldmann (1991), Tucker (1998), and Schweitzer *et al.* (2000) have discussed their validity and recently Schweitzer *et al.* (2006) considered *Laeviranina* as synonymous of *Raninoides*. Schweitzer *et al.* (2006) also provided the check list of the fossil and Recent species known to date.

Twelve fossil species are known from America: *R. eugenensis* Rathbun, 1926 (Oligocene – Oregon), *R. fulgidus* Rathbun, 1926 (Upper Eocene-Oligocene – Washington-Oregon), *R. oregonensis* Rathbun, 1926 (Oligocene – Oregon), *R. goedertorum* (Tucker, 1998) (Upper Eocene – Washington), *R. vaderensis* Rathbun, 1926 (Middle-Upper Eocene – Pacific Northwest), *R. dickersoni* Rathbun, 1926 (Middle Eocene – California), *R. acanthocolus* Schweitzer, Feldmann, González-Barba & Ćosović, 2006 (Eocene – Baja California), *R. proracanthus* Schweitzer *et al.*, 2006 (Eocene – Baja California), *R. slaki* Squires, 2001 (Eocene – California), *R. bournei* (Rathbun, 1928) (Paleocene – southcentral United States), *R. borealis* (Collins & Rasmussen, 1992) (Middle Paleocene – Greenland), *R. araucana* (Philippi, 1887) (Lower Eocene – Chile). Four fossil species are known from Indo-Pacific area: *R. sinuosus* (Collins & Morris, 1978) (Lower Eocene – Pakistan), *R. javanus* (Böhm, 1922) (Miocene – Java), *R. nodai* Karasawa, 1992 (Middle-Upper Eocene – Japan), *R. perarmata* (Glaessner, 1960) (Middle Eocene – New Zealand), *R. morrisi* Collins, Lee & Noad (Miocene – Borneo). Eigth fossil species are known from Europe: *R. glabra* (Woodward, 1871) (Lower Eocene – England), *R. gottschei* Böhm, 1927 (Lower Eocene – England), *R. treldenaesensis* Collins & Jakobsen, 2003 (Eocene – Denmark), *R. notopoides* (Bittner, 1883) (Eocene – Italy), *R. pulchra* (Beschin, Busulini, De Angeli & Tessier, 1988) (Middle Eocene – NE Italy), *R. budapestiniensis* (Lőrenthey, 1897) (Middle-Upper Eocene – Hungary and Italy), *R. fabianii* (Lőrenthey & Beurlen, 1929) (Middle-Upper Eocene – Hungary and Italy); *R. hollandica* (Collins, Fraaye, Jagt & v. Knippenberg, 1997) (Upper Oligocene - The Netherlands), and *R. pliocenicus* n. sp. (Pliocene – Italy).

Raninoides pliocenicus n. sp. shows most morphological affinities with *R. fabianii* (Lőrenthey & Beurlen, 1929) from the Upper Eocene of Hungary, Italy,

and probably Germany. In fact, this species also has a rostrum with rounded tip and elongate fissures on supraorbital margins (Lőrenthey & Beurlen, 1929; Förster & Mundlos, 1982; Beschin *et al.*, 2006). However *Raninoides fabianii* differs in having a longitudinal depression on the dorsal surface of the rostrum and ornamentation of dorsal surface of carapace with granules of different size.

Among the European species: *R. hollandica* differs from *R. pliocenicus* n. sp. for the narrower anterior margin and antero-lateral margins with small ridges; *R. glabra* has instead a wider carapace and stronger antero-lateral spines; *R. gottschei* differs in having rostrum narrower, almost straight supraorbital margin, and dorsal surface ridged in the median part; *R. reldenaesensis* has a longer carapace and less convex lateral margins; *R. pulchra* has rostrum shorter, bifid anterolateral spines, and smooth dorsal surface of carapace; *R. budapestiniensis* and *R. notopoides* both have shorter carapace.

Raninoides pliocenicus n. sp. represents the youngest species of the genus in Europe.

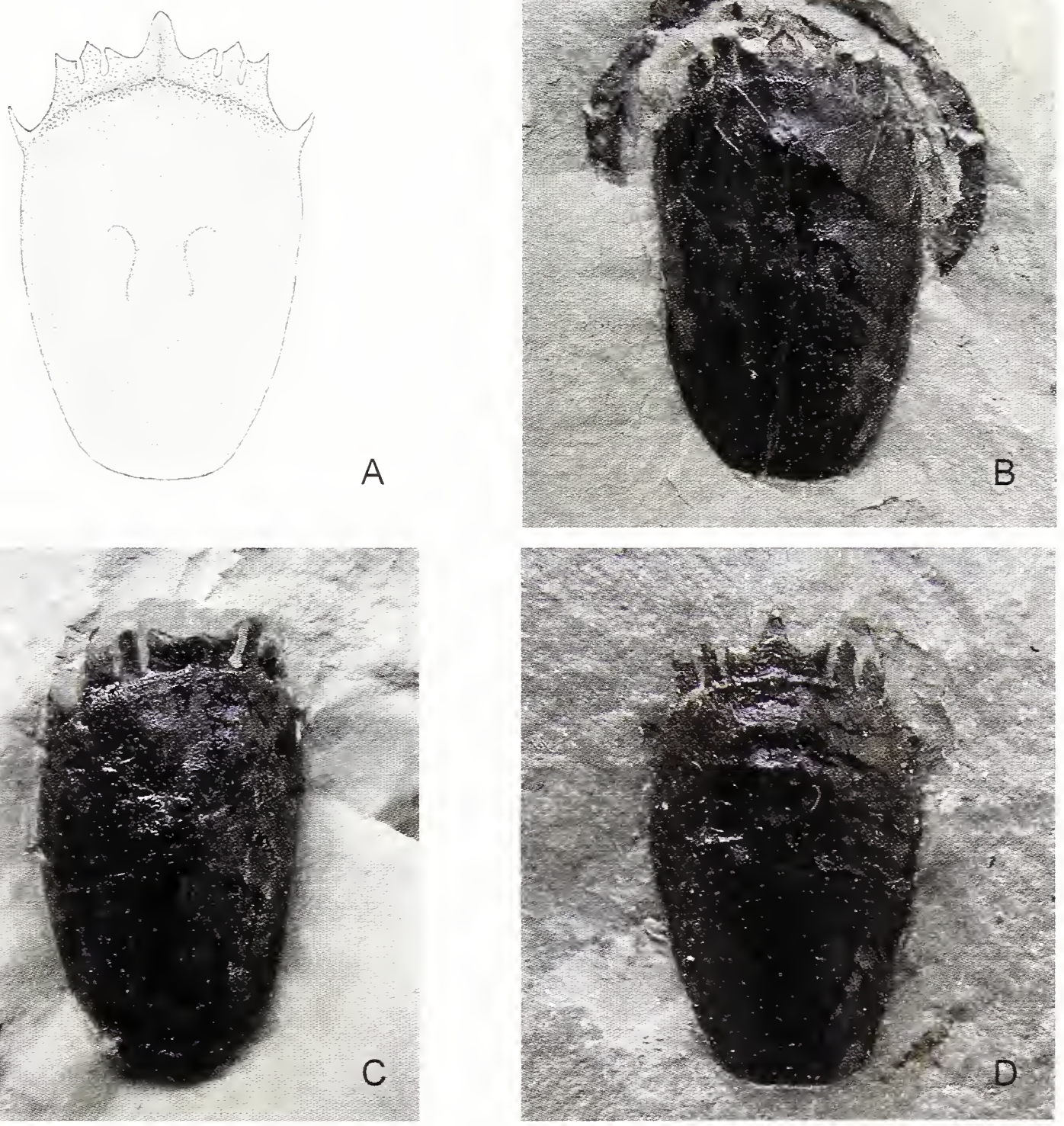

Fig. 5 – *Raninoides pliocenicus* n. sp. A) reconstruction of carapace/ricostruzione del carapace. B) CF-TCR1, paratype/paratipo (x 1.5). C) GPDG 0067, paratype/paratipo (x 1.8). D) GPDG 0068, holotype/olotipo (x 2.7).

Subsection Eubrachyura Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Superfamily Dorippoidea MacLeay, 1838
Family Dorippidae MacLeay, 1838
Genus *Medorippe* Manning & Holthuis, 1981

Type species: *Cancer lanatus* Linnaeus, 1767.

Medorippe ampla Garassino, De Angeli, Gallo & Pasini, 2004
Fig. 6

2004 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini; p. 260, Text-figs. 5, 6 a-b
2006 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini *in* De Angeli & Garassino; p. 40

Stratigraphic range: Upper Miocene (Messinian).
Type locality: Rio Popogna (Livorno).
Material and measurements: two complete specimens in dorsal view.
GPDG 0070 – lcxp: 10.5; wcxp: 12.7; wo-f: 7.4
GPDG 0071 – lcxp: 12.5; wcxp: 14.4; wo-f: 9.6

Discussion. *Medorippe ampla* was described by two specimens from the Messinian (Upper Miocene) of Cocconato (Asti, Piemonte) (Garassino *et al.*, 2004). The main morphological characters of the species are as follows: subhexagonal carapace, weakly convex, wider than long; wide orbito-frontal margin; bilobate front; wide orbits marked by a well developed extraorbital tooth; divergent antero-lateral margins with an epibranchial spine; elongate postero-lateral margins; well marked regions with granulations; deep cervical and cardiac grooves; narrow cardiac region with Y-shaped granulate ridge anteriorly; hepatic and branchial regions with granulate ridges. The studied specimens have the same characters as the type specimens from Piemonte. The only difference is a lower density of granulation on the ridges of the carapace regions.

Fig. 6 – *Medorippe ampla* Garassino, De Angeli, Gallo & Pasini, 2004, GPDG 0070 (x 3.7).

Family Ethusidae Guinot, 1977
Genus *Ethusa* Roux, 1830

Type species: *Cancer mascarone* Herbst, 1785.

Ethusa popognensis n. sp.
Fig. 7 A-B

Diagnosis: carapace longitudinally ovate, wider posteriorly; front with four teeth; antero-lateral margins elongate and divergent; posterior margin concave; distinct regions with small tubercles in median part; branchial regions with two grooves and two granulate ridges.

Etymology: the trivial name alludes to Rio Popogna where the studied specimen was discovered.

Holotype: GPDG 0072.

Stratigraphic range: Upper Miocene (Messinian).

Type locality: Rio Popogna (Livorno).

Material and measurements: one complete specimen in dorsal view.

GPDG 0072 – lcxp: 18.3; wo-f: 10.2

Description: carapace slightly convex transversely, longitudinally ovate, wider posteriorly. Orbito-frontal margin occupies the entire anterior part of dorsal surface. Front about 2/5 of orbito-frontal width. Front with two pairs of triangular teeth separated by a V-shaped depression in median part. Orbits narrow. Supraorbital margins marked by a narrow fissure. Preorbital margin slightly raised. Strong extraorbital tooth somewhat elongate. Antero-lateral margins elongate and divergent. Postero-lateral margins converge strongly to posterior margin. Posterior margin wide, concave in median part, and ridged superficially. Dorsal regions distinct. One weak longitudinal groove in frontal region. Protogastric region marked by a weak hepatic groove. Metagastric, urogastric, and cardiac regions well marked along margins by branchiocardiac groove. Oval cardiac region. Intestinal region depressed. Subtriangular hepatic region, separated from branchial regions by cervical groove. Small oval dip close to the depression of cervical groove. Well-developed branchial regions crossed transversely by two branchial grooves forming two granulate ridges. Dorsal regions smooth. Small tubercles are located in the median part of gastric, cardiac, hepatic, and branchial regions.

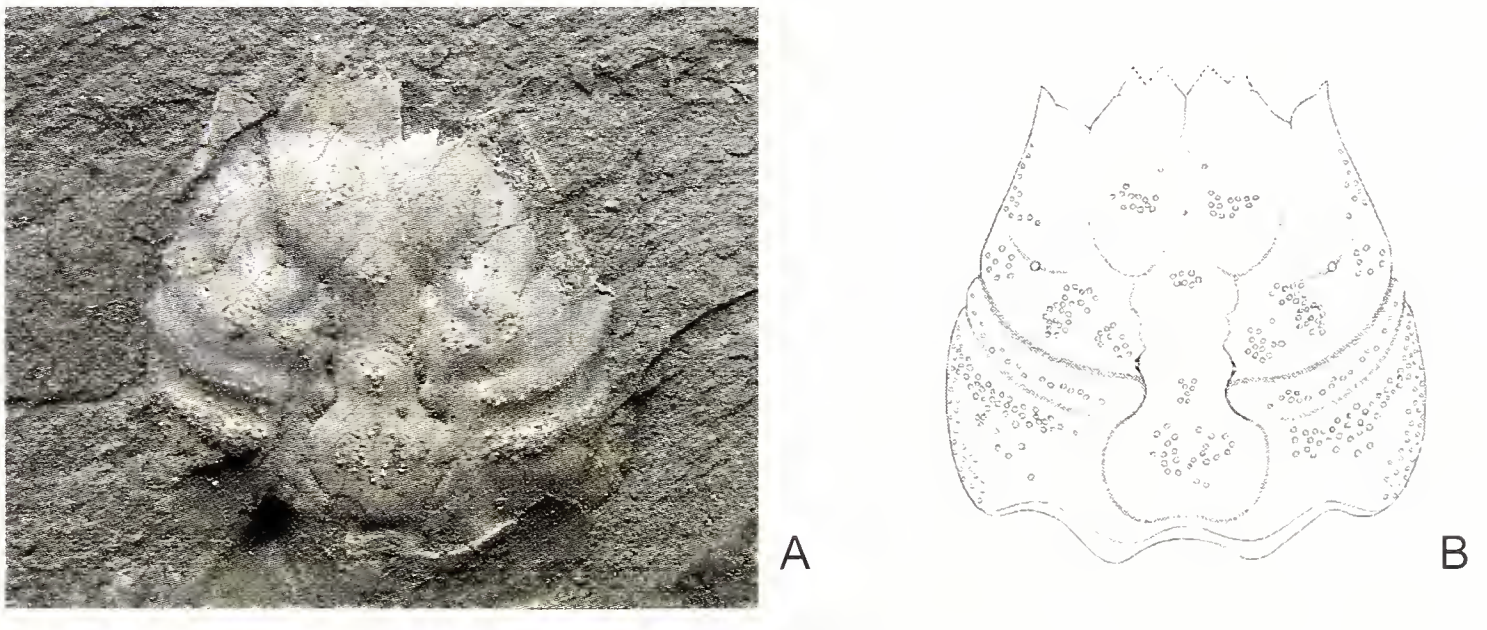

Fig. 7 – *Ethusa popognensis* n. sp., GPDG 0072, holotype/olotipo. A) dorsal view/norma dorsale (x 2.2). B) reconstruction of carapace/ricostruzione del carapace.

Discussion. *Ethusa* Roux, 1830, includes 43 Recent species (Ng *et al.*, 2008) widespread usually in shallow environments. The rare fossil species are restricted to the Cenozoic. *Ethusa chibai* Karasawa, 1993 (Lower Pliocene, Japan) differs from *E. popognensis* n. sp. by exhibiting a carapace longer, dorsal surface of carapace smoother, and shallow branchiocardiac grooves. *Ethusa evae* Müller & Collins, 1991 [Upper Eocene (Priabonian), Hungary] has instead a subsquare carapace and orbits wider. *Ethusa berica* De Angeli & Beschin, 2008 (Lower Oligocene, Vicenza, Italy) has a carapace longer and smooth and extraorbital spines more developed and directed obliquely.

Müller (1984b) and Via Boada (1988) have reported the presence of a probable new subspecies of *E. mascarone* (Herbst, 1785) from the Messinian (Miocene) of Santa Pola (Alicante, Spain). Artal & Gilles (2007) have recorded *Ethusa* sp. from the Miocene of Pignan (southeast France). Marangon & De Angeli (2007) have recorded a new species of *Ethusa* from the Lower Oligocene of Bacino Ligure Piemontese having a carapace longer with smooth regions.

Superfamily Calappoidea H. Milne Edwards, 1837
Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795

Type species: *Cancer granulatus* Linnaeus, 1758.

Calappa granulata (Linnaeus, 1758)
Fig. 8 A-B

1758 – *Cancer granulatus* Linnaeus; p. 627
1767 – *Cancer granulatus* Linnaeus; p. 533
1798 – *Calappa granulata* (Linnaeus) *in* Fabricius; p. 346
1816 – *Calappa granulata* (Linnaeus) *in* Risso; p. 18
1825 – *Calappa granulata* (Linnaeus) *in* Desmarest; p. 109, Pl. 10 (fig. 1)
1828 – *Calappa granulata* (Linnaeus) *in* Roux; Pl. 2 (Fig. 13), Pl. 16 (figs. 1-7)
1861b – *Calappa granulata* (Linnaeus) *in* A. Milne Edwards; p. 88
1863 – *Calappa granulata* (Linnaeus) *in* Heller; p. 130, Pl. 4 (fig. 3)
1914 – *Calappa granulata* (Linnaeus) *in* M. Gemmellaro; p. 80, Pl. 1 (figs. 9-10)
1918 – *Calappa granulata* (Linnaeus) *in* Pesta; Text-fig. 97
1929 – *Calappa granulata* (Linnaeus) *in* Glaessner; p. 70
1936 – *Calappa granulata* (Linnaeus) *in* Nobre; p. 81, Pl. 28 (figs. 73-74)
1940 – *Calappa granulata* (Linnaeus) *in* Bouvier; p. 203, Text-fig. 203, Pl. 7 (fig. 1)
1946 – *Calappa granulata* (Linnaeus) *in* Zariquiey Alvarez; p. 143, Text-fig. 163
1965 – *Calappa granulata* (Linnaeus) *in* Forest; p. 362
1968 – *Calappa granulata* (Linnaeus) *in* Zariquiey Alvarez; p. 315, Text-figs. 105 c, 107 a
1992 – *Calappa granulata* (Linnaeus) *in* Falciai & Minervini; p. 181, Pl. 12 (fig. 4)
2004a – *Calappa granulata* (Linnaeus) *in* Garassino & De Angeli; p. 38, Text-fig. 4 (1-3)
2004 – *Calappa granulata* (Linnaeus) *in* Garassino, De Angeli, Gallo & Pasini; p. 264, Text-fig. 7 a-c
2006 – *Calappa granulata* (Linnaeus) *in* De Angeli & Garassino; p. 40

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Presciano and Terre Rosse (Siena).
Material and measurements: one complete specimen in dorsal view (GPDG 0073 from Presciano); one movable finger of right cheliped (GPDG 0074 from Stroncoli).

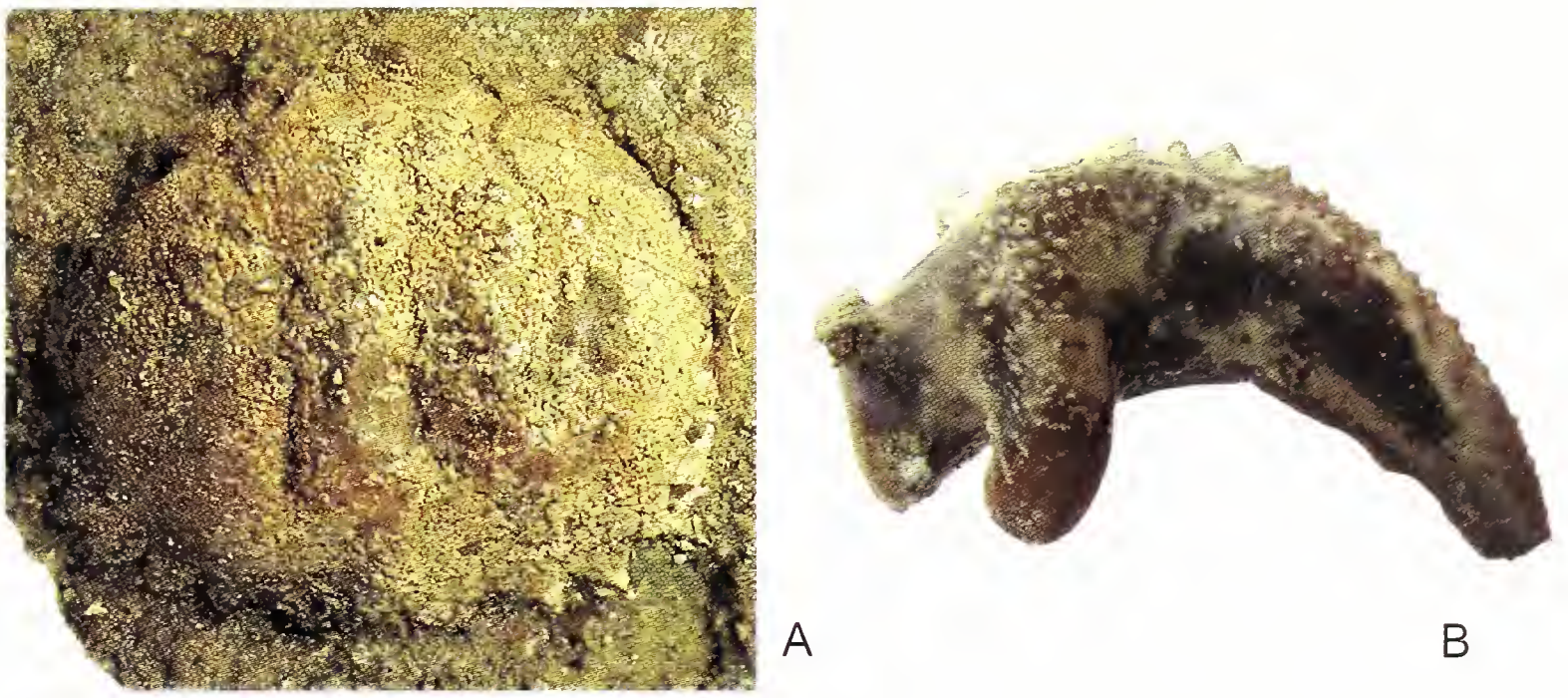

Fig. 8 – *Calappa granulata* (Linnaeus, 1758). A) GPDG0073 (x 1.7). B) GPDG 0074, dactylus (x 3).

GPDG 0073 – lcxp: 22.8; wcxp: 27.9; wo-f: 9.4
GPDG 0074 – lmf: 20.3

Discussion. The carapace is suboval, slightly convex, and mainly elevated in the posterior part. The front is narrow and bilobate. The supra-orbital margins are short and slightly raised. The antero-lateral margins are convex with small teeth. The postero-lateral margins are strongly convergent with triangular teeth. The regions are well marked by two longitudinal grooves which divide the dorsal surface of carapace into three parts. Some tubercles are present on the branchial regions.

Even though the specimen from Presciano is not well preserved, it shows close morphological affinities with *Calappa granulata* (Linnaeus, 1758), already known from the Pliocene of Orciano (Pisa), Altavilla (Palermo), Emilia Romagna, and from the Pleistocene of Monte Pellegrino (Palermo, Sicilia) (Ristori, 1891; M. Gemmellaro, 1914; Garassino & De Angeli, 2004).

Superfamily Leucosioidea Samouelle, 1819
Family Leucosiidae Samouelle, 1819
Genus *Ebalia* Leach, 1817

Type species: *Ebalia bryerii* Leach, 1817.

Ebalia cfr. *E. deshayesi* Lucas, 1846
Fig. 9

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).
Type locality: Poggio alla Staffa (Siena).
Material and measurements: one complete specimen in dorsal view.
GPDG 0075 – wcxp: 5.6
Description: Small-sized specimen lacking the front. Octagonal carapace, slightly wider than long, convex dorsally having small irregular tubercles. Antero-lateral margins as long as the postero-lateral margins. The median parts of lat-

eral margins are parallel and slightly concave. The postero-lateral margins have a marked concavity. The posterior margin has the median part slightly concave and posterior angles with two strong rounded protuberances. The dorsal regions are not distinct. The gastric region has three granulate protuberances: one mesogastric and one on both protogastric regions. Other two granulate protuberances are present on the branchial regions. The cardiac region has a wide and developed oval bulge.

Discussion. The high degree of sexual dimorphism among adults, the remarkable morphological differences between adults and juvenile stages, and the extremely variable morphology of carapace in the same species, makes the right classification of the species ascribed to this genus difficult.

The studied specimen shows morphological affinities with the Recent *Ebalia deshayesi* Lucas, 1846, widespread in Atlantic (Balearic Islands) and Mediterranean Sea, living in sandy and muddy bottoms (Zariquiey Alvarez, 1968). Common characters between the fossil specimen and the Recent species are the octagonal carapace, slightly wider than long, having gastric and branchial protuberances. However the studied specimen differs from the Recent species in having the postero-lateral margins more concave.

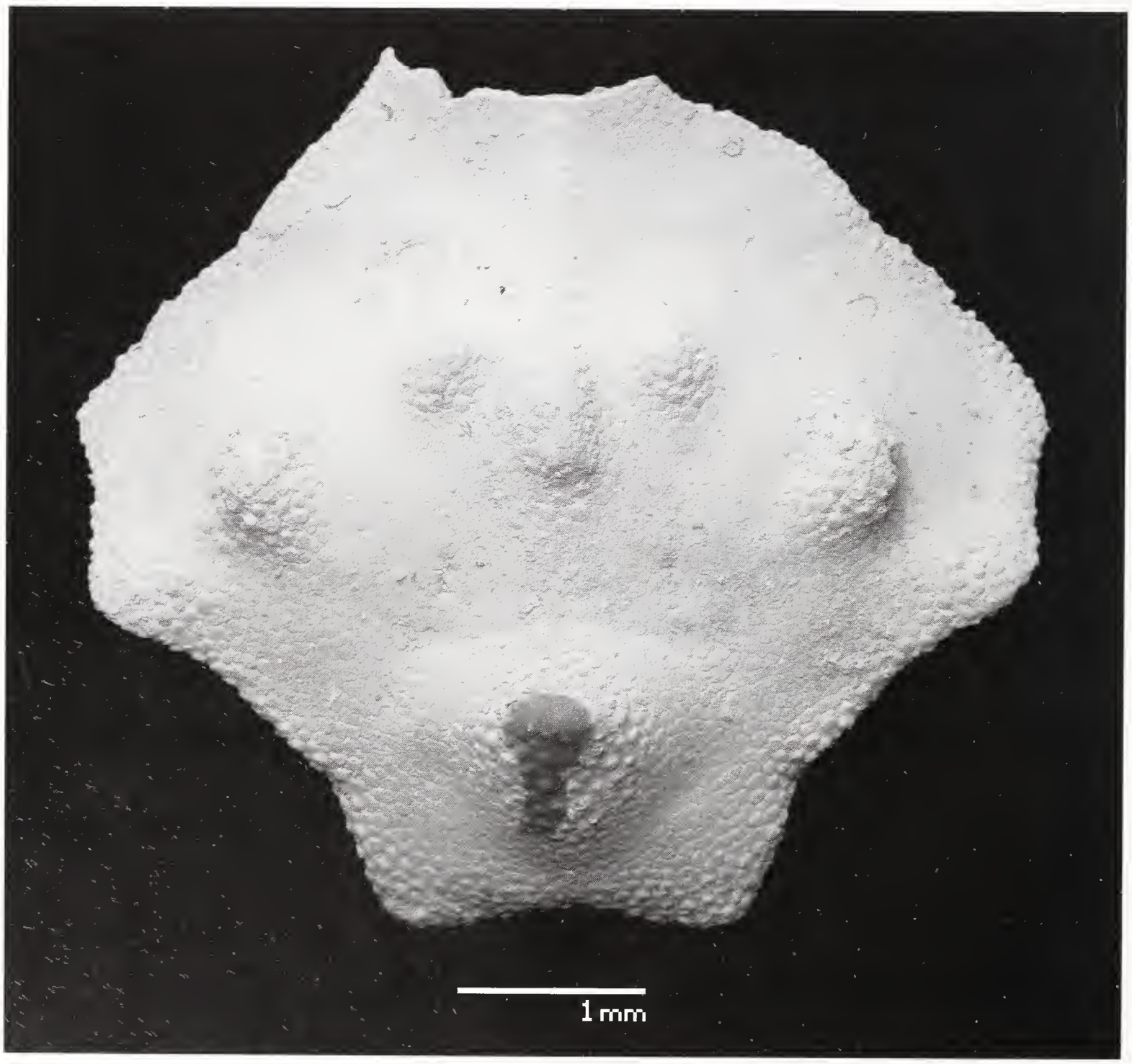

Fig. 9 – *Ebalia* cfr. *deshayesi* Lucas, 1846, GPDG0075.

Ebalia cranchii Leach, 1817
Fig. 10

1817 – *Ebalia cranchii* Leach; Pl. 25 (figs. 7-11)
1846 – *Ebalia cranchii* Leach *in* Bell; p. 148
1855 – *Ebalia cranchii* Leach *in* Bell; p. 303
1891b – *Ebalia cranchii* var. *romana* Ristori; p. 22, Pl. 1 (figs. 21-23), **nov. syn.**
1892a – *Ebalia cranchii* Leach *in* Ristori; p. 88
1914 – *Ebalia cranchii* var. *romana* Ristori *in* M. Gemmellaro; p. 78, Pl. 1 (figs. 3-6)
1929 – *Ebalia cranchii* var. *romana* Ristori *in* Glaessner; p. 144
1936 – *Ebalia cranchii* Leach *in* Nobre; p. 78, Pl. 26 (fig. 64)
1940 – *Ebalia cranchii* Leach *in* Bouvier; p. 209, Pl. 7 (figs. 7-10)
1946 – *Ebalia cranchii* var. *romana* Ristori *in* Maxia; p. 132, Pl. 1 (fig. 1)
1956 – *Ebalia cranchii* Leach *in* Monod; p. 122, Text-figs. 145-146
1965 – *Ebalia cranchii* Leach *in* Forest; p. 364-371, Text-fig. 25 a-b, Pl. 2 (figs. 1-2)
1968 – *Ebalia cranchii* Leach *in* Zariquiey Alvarez; p. 329, Text-figs. 108 a-b, 111 b, d, 111 A, a, 111 C, b
1981 – *Ebalia cranchii* var. *romana* Ristori *in* Delle Cave; p. 45
1992 – *Ebalia cranchii* Leach *in* Falciai & Minervini; p. 184
2004a – *Ebalia cranchii* Leach *in* Garassino & De Angeli; p. 39, Text-figs. 3 (7, 8), 4 (4), 5, 6
2006 – *Ebalia cranchii* Leach *in* De Angeli & Garassino; p. 45

Stratigraphic range: Plio-Pleistocene.
Type locality: Parrana San Giusto (Livorno).
Material and measurements: one complete carapace.
GPDG 0089: lcxp: 5.4; wcxp: 5.1

Fig. 10 – *Ebalia cranchii* Leach, 1817, GPDG0089 (x 10).

Discussion. The studied specimen shows morphological affinities with *Ebalia cranchii* Leach, 1817, widespread in the Mediterranean Sea and discovered in the fossil record from the Pliocene and Pleistocene of Emilia Romagna, Lazio, and Sicilia (Ristori, 1891; M. Gemmellaro, 1914; Maxia, 1946; Garassino & De Angeli, 2004). The carapace is longer than wide, with convex lateral margins and dorsal surface with five weak granulate protuberances. The front is wider and more raised superficially than *Ebalia* cfr. *E. deshayesi* Lucas, 1846, and *E. fucinii* Ristori, 1892. Many specimens of *E. cranchii* have been recently reported from the Pliocene and Pleistocene of Emilia Romagna by Garassino & De Angeli (2004).

Ebalia fucinii Ristori, 1892
Fig. 11

1892 – *Ebalia fucinii* Ristori, p. 88, fig. 2
1929 – *Ebalia fucinii* Ristori *in* Glaessner, p. 144
1981 – *Ebalia fucinii* Ristori *in* Delle Cave, p. 45
2004 – *Ebalia fucinii* Ristori *in* Garassino & De Angeli, p. 40
2006 – *Ebalia fucinii* Ristori *in* De Angeli & Garassino, p. 43

Stratigraphic range: Plio-Pleistocene.
Type locality: Parrana San Giusto (Livorno).

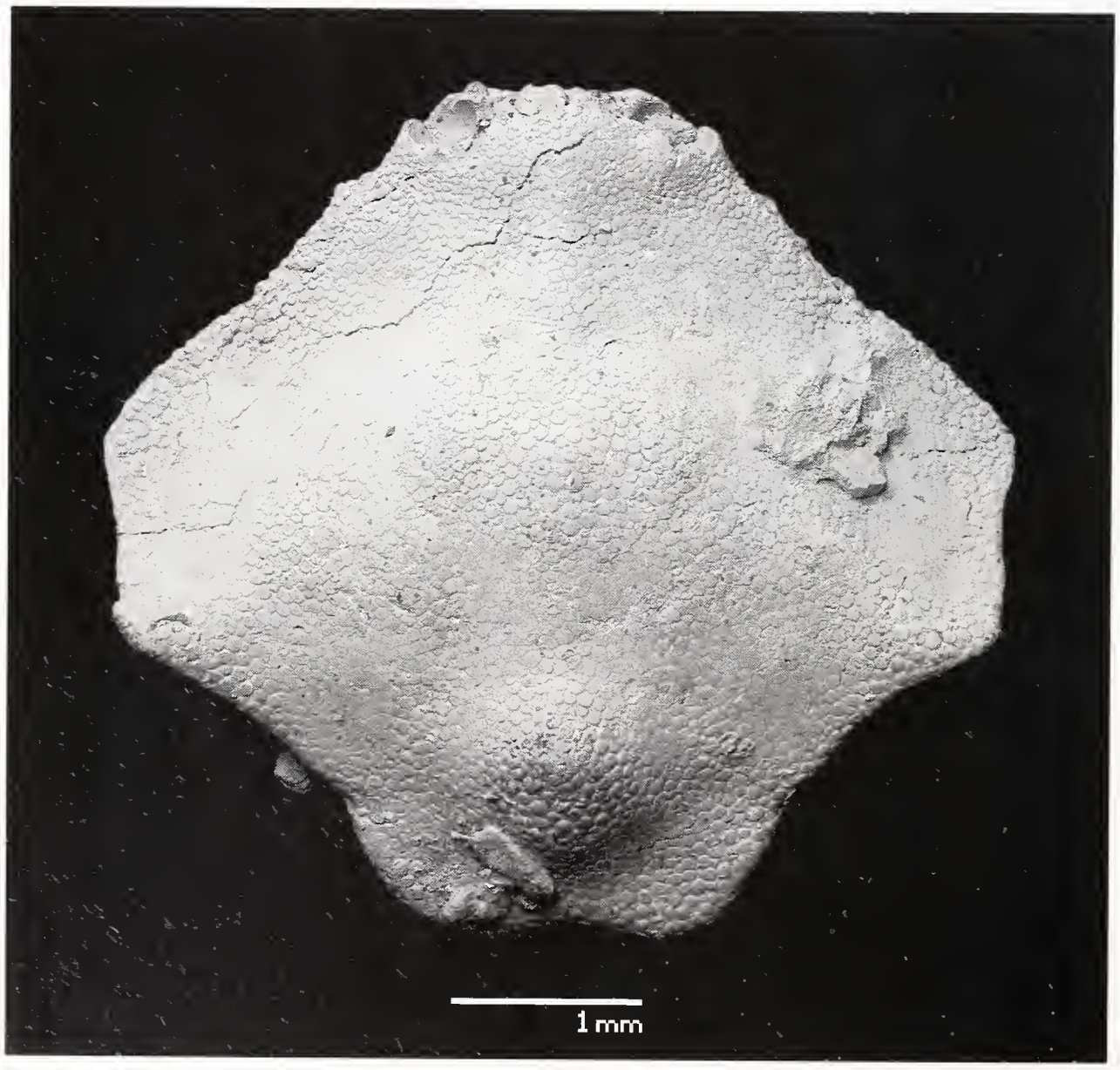

Fig. 11 – *Ebalia fucinii* Ristori, 1892, GPDG0076.

Material and measurements: one complete specimen in dorsal view.
GPDG 0076 – lcxp: 4.9; wcxp: 5.1

Description: Octagonal carapace, slightly wider than long, superficially concave, having small and weak irregular tubercles. The orbito-frontal margin is about 1/3 the maximum width of carapace. The front is incomplete in the distal part. The orbits are rounded and marked by two narrow supraorbital fissures. The antero-lateral margins are as long as the postero-lateral margins. The median parts of lateral margins are almost parallel with slightly concave margins. The posterior parts of lateral margins form an acute angle, raised superficially, extending onto the branchial regions by a weak oblique ridge. The postero-lateral margins are concave. The posterior margin is slightly concave in tha median part with two rounded protuberances on the angles. Dorsal regions are not distinct. The cardiac region has a large oval bulge.

Discussion. The studied specimen shows morphological affinities with *Ebalia fucinii*, described by Ristori (1892) from the Pliocene of Spicchio (Empoli).

Genus *Ilia* Leach, 1817

Type species: *Cancer nucleus* Linnaeus, 1758.

Ilia pliocenica Ristori, 1891
Fig. 12 A-B

1891 – *Ilia pliocenica* Ristori; p. 10, Pl. 1 (figs. 8, 9, 11-12, 14)
1892 – *Ilia pliocenica* Ristori *in* Ristori; p. 86
1929 – *Ilia pliocenica* Ristori *in* Glaessner; p. 225
1981 – *Ilia pliocenica* Ristori *in* Dalle Cave; p. 45
2004 – *Ilia pliocenica* Ristori *in* Garassino & De Angeli; p. 40, fig. 4 (5)
2004 – *Ilia pliocenica* Ristori *in* Garassino, De Angeli, Gallo & Pasini; p. 266, figs. 8 a, b
2006 – *Ilia pliocenica* Ristori *in* De Angeli & Garassino; p. 46

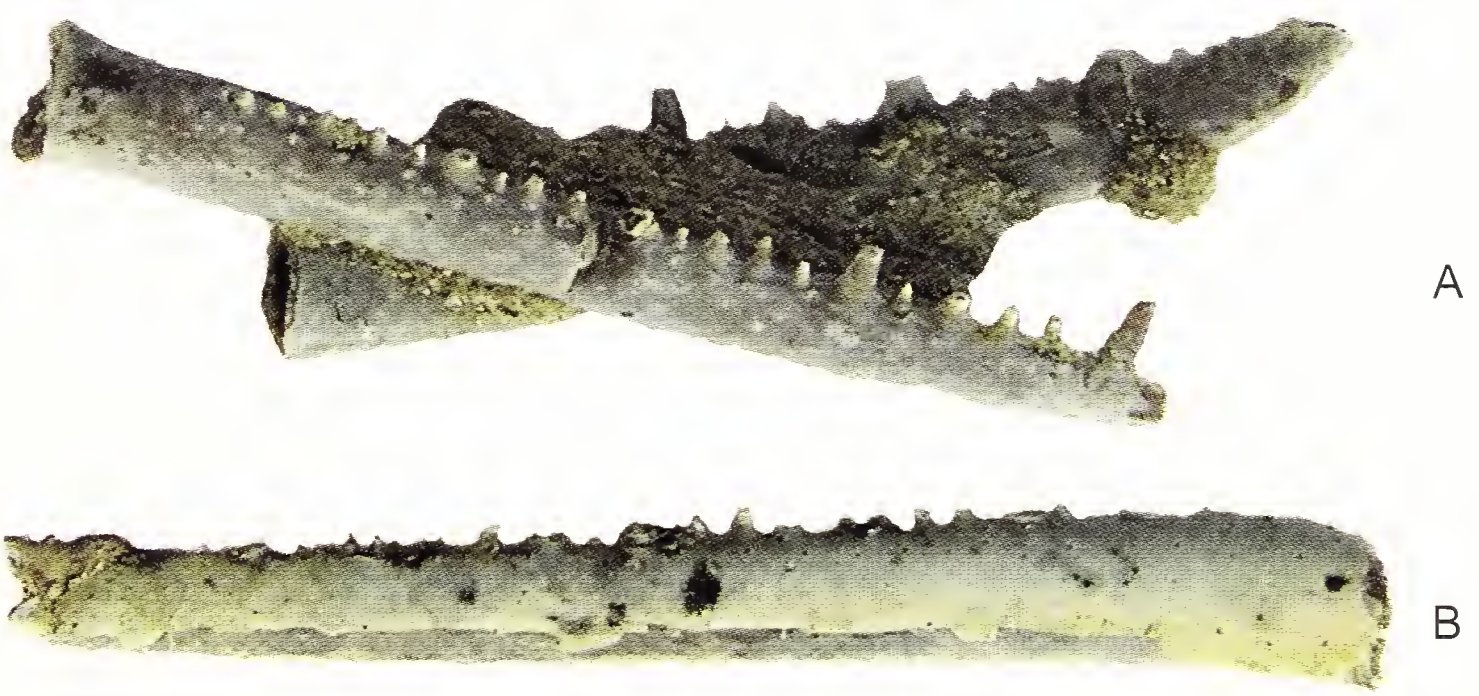

Fig. 12 – *Ilia pliocenica* Ristori, 1891, movable finger or fixed finger / dito mobile o dito fisso. A) GPDG 0077 (x 9). B) GPDG 0078 (x 10)

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).
Type locality: Ciuciano and Pietrafitta (Siena).
Material: four specimens (fragments of chelipeds) (GPDG 0077, 0078 from Pietrafitta; 0079, 0080 from Ciuciano).
Discussion. The studied specimens include fragments of elongated movable and fixed fingers, with the occlusal margin having many perpendicular spines of different size. *Ilia pliocenica* has been recorded from the Pliocene and Pleistocene of Spicchio (Empoli), Arda River (Piacenza), Masserano, and Cossalto (Biella) (Ristori, 1891; Garassino & De Angeli, 2004; Garassino *et al.*, 2004). *Ilia pliocenica* probably represents the ancestor of the Recent species *I. nucleus* Linnaeus, 1758, that is widespread in the Mediterranean Sea.

Genus *Palaeomyra* A. Milne Edwards, 1861

Type species: *Palaeomyra bispinosa* A. Milne Edwards *in* E. Sismonda, 1861.

Palaeomyra bispinosa A. Milne Edwards, 1861
Fig. 13

1861 – *Palaeomyra bispinosa* A. Milne Edwards *in* Sismonda, p. 16, Figs. 18-20
1969 – *Palaeomyra bispinosa* A. Milne Edwards *in* Glaessner, p. R498
2004 – *Palaeomyra bispinosa* A. Milne Edwards *in* Garassino, De Angeli, Gallo & Pasini, p. 267, Figs. 9, 10 a, b
2006 – *Palaeomyra bispinosa* A. Milne Edwards *in* De Angeli & Garassino, p. 46

Stratigraphic range: Pliocene *sensu lato*.
Type locality: La Strolla (Siena).
Material and measurements: one complete specimen in dorsal view.
GPDG 0081 – lcxp: 12.7; wcxp: 9.9; wf: 4.2

Fig. 13 – *Palaeomyra bispinosa* A. Milne Edwards, 1861, GPDG 0081 (x 4.3).

Discussion. *Palaeomyra* was described by A. Milne Edwards *in* E. Sismonda (1861), based upon the morphological characters of *P. bispinosa* A. Milne Edwards *in* E. Sismonda (1861), represented by one inner cast of a carapace from the Miocene of Torino (Piemonte). Recently Garassino *et al.* (2004) have recorded six complete specimens of this species from the Oligocene of Morbello (Alessandria) and from the Miocene of Cocconato (Asti).

The studied specimen shows the typical morphological characters of this species, even though the spines located on the angles are less developed of those of the specimens from Piemonte.

Palaeomyra bispinosa is similar to *P. globulosa* (Müller, 1976) from the Miocene of Hungary. However the Hungarian species has a more elongate carapace and more tuberculate dorsal surface. *Palaeomyra* shows close morphological affinities with the Recent *Pseudomyra mbizi* Capart, 1951, widespread along the western coasts of Africa.

Superfamily Portunoidea Rafinesque, 1815
Family Portunidae Rafinesque, 1815
Subfamily Polybiinae Ortmann, 1893
Genus *Liocarcinus* Stimpson, 1871

Type species: *Portunus holsatus* Fabricius, 1798.

Liocarcinus sp.
Fig. 14

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).
Type locality: Pietrafitta (Siena).
Material: two fixed fingers of propodi of chelipeds (GPDG 0082, 0083).
Discussion. The two studied specimens include only fixed fingers belonging to the right and left propodi of chelipeds. The fixed fingers are elongate and curved with a lower concave margin and occlusal margin with some teeth. The outer surface has two longitudinal ridges and one row of orifices, aligned longitudinally. These fixed fingers show close affinities with those of the representatives of *Liocarcinus* Stimpson, 1871, widespread in the Mediterranean Sea from the Miocene to Recent.

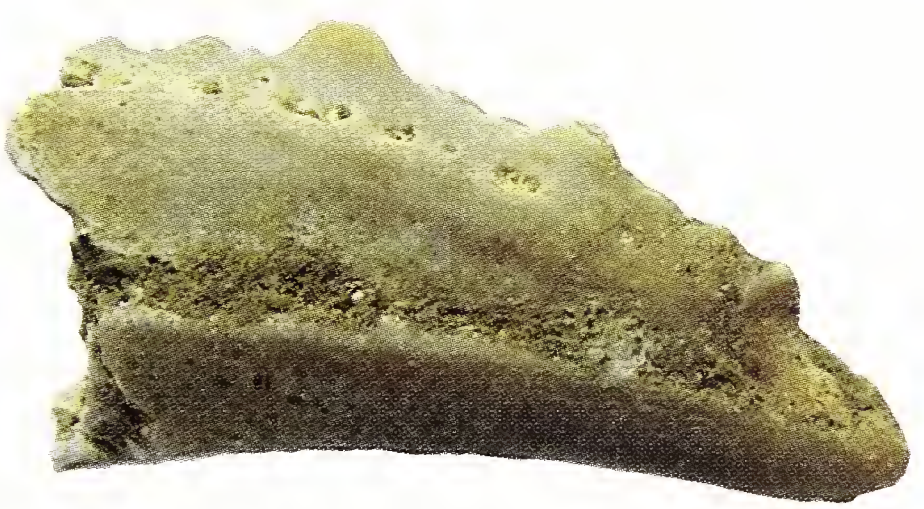

Fig. 14 – *Liocarcinus* sp., GPDG 0082, fixed finger/dito fisso (x 7).

Superfamily Pilumnoidea Samouelle, 1819
Family Pilumnidae Samouelle, 1819
Genus *Pilumnus* Leach, 1815

Type species: *Cancer hirtellus* Linnaeus, 1761.

Pilumnus ristorii new replacement name for *Pilumnus spinosus* Ristori, 1886
Fig. 15

Stratigraphic range: Lower Pliocene (Piacentian).
Type locality: Terre Rosse (Siena).
Material and measurements: one right propod.
GPDG 0069 – lp: 5.5; h: 5.9; tp: 3.2; lt: 9.4

Description. Suboval carpus, raised superficially, with upper margin and outer surface having strong spines. Subcylindrical propodus, longer than wide. Upper margin slightly convex with four pointed spines. Lower margin almost straight. Outer surface with rows of spines. Spines of upper margin and upper part of outer surface incomplete distally. Spines of lower part of outer surface small or with small tubercles. Fixed finger incomplete slightly directed backwards with some tubercles.

Discussion. The shape and the ornamentation with strong spines located in longitudinal rows resemble *Pilumnus spinosus* Ristori, 1886, described by one carpus and one propodus of a right chela from the Middle Pliocene of S. Venanzio (Modena). The propodus described by Ristori shows fewer rows of spines covering only the upper and medial parts of the outer surface, while in the studied specimen the outer surface is totally covered by rows of spines or tubercles. Probably the presence of many rows of spines is correlated with sexual dimorphism.

Pilumnus spinosus Ristori, 1886, was preoccupied by *Pilumnus spinosus* Filhol, 1885. Thus, we provide herein the new replacement name *Pilumnus ristorii* to replace *Pilumnus spinosus* Ristori, 1886.

Fig. 15 – *Pilumnus ristorii* new replacement name, GPDG 0069, right propod/propodus destro (x 10)

Superfamily Xanthoidea MacLeay, 1838
Family Xanthidae MacLeay, 1838
Genus *Monodaeus* Guinot, 1967

Type species: *Xantho couchii* Couch, 1815.

Monodaeus bortolottii Delle Cave, 1988
Fig. 16

Stratigraphhic range: Pliocene *sensu lato*.
Type locality: Monterotondo Marittimo (Grosseto).
Material and measurements: one carapace incomplete in anterior part.
IGF 14636E – lcxp: 8; wcxp: 10.8

Discussion. Suboctagonal carapace, wider than long, slightly convex superficially. Front with margin almost straight with one weak median incision. Supraorbital margins separated from the front by a depression. Antero-lateral margins short, convex, and serrate. Postero-lateral margin long and convergent. Posterior margin straight in median part and convex on margins with a granulate ridge. Dorsal regions well marked by grooves. Frontal region wide and depressed in median part. Epigastric lobes wide and raised. Suboval protogastric regions well marked. Subpentagonal mesogastric regions with anterior process narrow and elongate between protogastric regions. Wide cardiac region well marked by branchiocardiac grooves. Hepatic regions small and poorly marked. Branchial regions wide and well marked. Dorsal surface with small tubercles. Anterior regions with some granulate striae.

The studied specimen shows morphological affinities with *Monodaeus bortolottii* Delle Cave, 1988, described by one inner mould of carapace with chelipeds partially preserved from the Lower Pliocene (Piacentian) of Botro dell'Alpino, close to Volterra.

Fig. 16 – *Monodaeus bortolottii* Delle Cave, 1988, IFG 14636E (x 5.5).

Superfamily Eriphioidea MacLeay, 1838
Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817

Type species: *Cancer spinifrons* Herbst, 1785.

Eriphia cocchii Ristori, 1886
Figs. 17 A-B

1886 – *Eriphia cocchii* Ristori; p. 105, Pl. 2 (figs. 3, 4, 11, 13), Pl. 3 (figs. 1, 2)
1886 – *Eriphia punctulata* Ristori; p. 109, Pl. 2 (figs. 2, 15, 16)
1891 – *Eriphia cocchii* Ristori *in* Ristori; p. 9
1910 – *Eriphia cocchii* Ristori *in* Fucini; p. 3, figs. 1 a, c, 2
1929 – *Eriphia cocchii* Ristori *in* Glaessner; p. 149
1981 – *Eriphia cocchii* Ristori *in* Delle Cave; p. 46
1981 – *Eriphia punctulata* Ristori *in* Delle Cave; p. 47
2006 – *Eriphia cocchii* Ristori *in* De Angeli & Garassino; p. 67

Stratigraphic range: Lower Pliocene (Zanclean-Piacentian).

Type locality: Balconevisi (San Miniato – Pisa), Pietrafitta and Terre Rosse (Siena).

Material and measurements: one complete specimen from Balconevisi (San Miniato – Pisa) (MSNM i27214); one fixed finger of right cheliped from Pietrafitta (Siena) (MSNM i27215); one movable finger of right cheliped from Terre Rosse (Siena) (GPDG 0084).

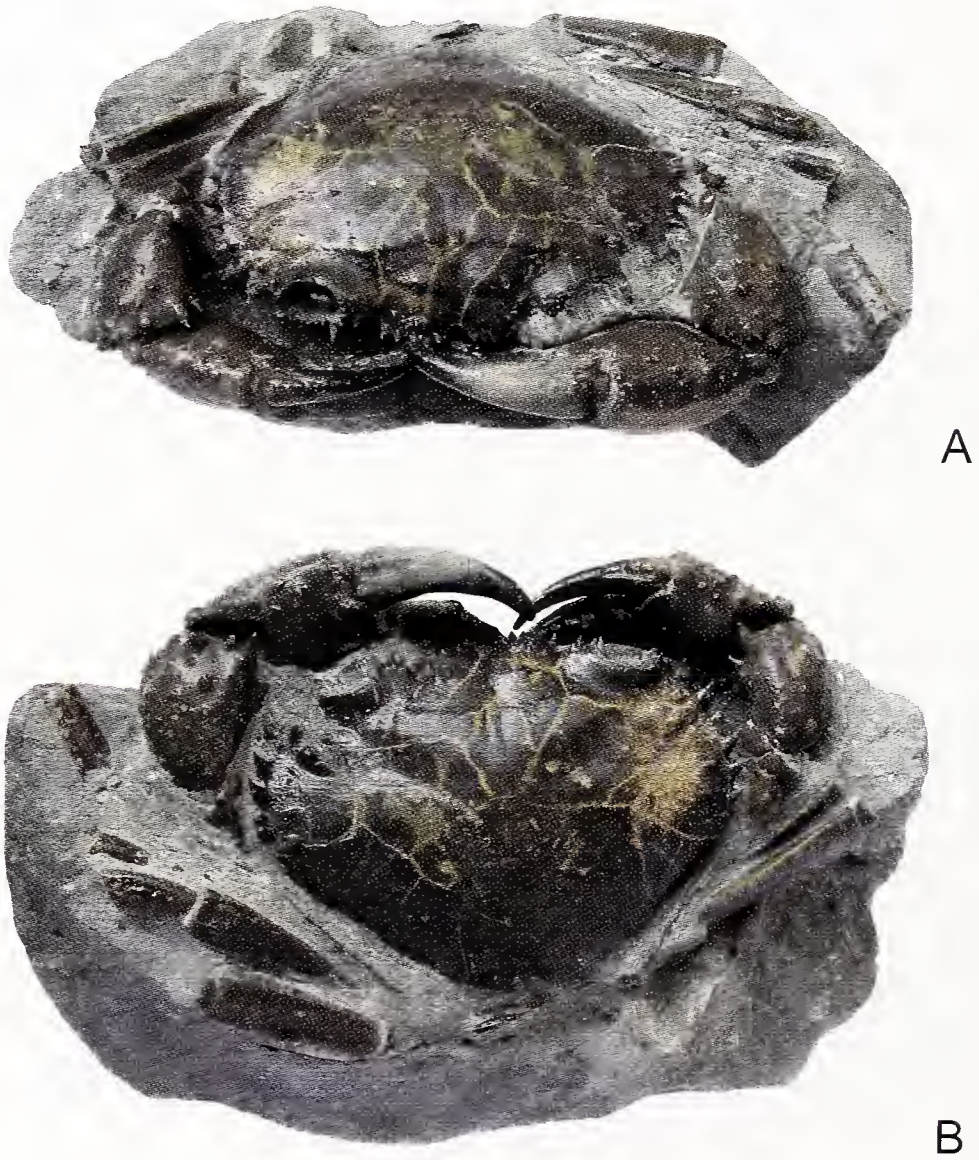

Fig. 17 – *Eriphia cocchii* Ristori, 1886, MSNM i27214. A) frontal view/norma frontale. B) dorsal view/norma dorsale (x 0.6).

MSNM i27214 – lcxp: 45; wcxp: 60.6; wo-f: 44.2
MSNM i27215 – lff: 23.7
GPDG 0084 – lmf: 20.1

Discussion. The complete specimen has a carapace with spinose frontal margin and antero-lateral margins. The orbits have a raised, serrated margin with some spines. The regions are not well marked and only slightly granulated. Some tubercles are present on hepatic regions. The chelae are well developed, heterochelous, with carpus and propodus having spines.

Eriphia cocchii has been recorded from the Pliocene of Montrappoli (Val d'Elsa – Firenze) and Montebicchieri (San Miniato – Pisa) (Ristori, 1886). Later Fucini (1910) reported one specimen of this species from the Pliocene of Spicchio (Empoli). Moreover Fucini (1910) considered *E. punctulata*, described by Ristori (1886) from the Pliocene of Montrappoli as synonymous of *E. cocchii*.

Family Goneplacidae MacLeay, 1838
Subfamily Goneplacinae MacLeay, 1838
Genus *Goneplax* Leach, 1814

Type species: *Cancer rhomboides* Linnaeus, 1758.

Goneplax gulderi Bachmayer, 1953
Fig. 18 A-B

1895 – *Goneplax sacci* Crema; p. 674, Text-fig. 15
1907 – *Goneplax* cfr. *sacci* Crema *in* Lőrenthey; p. 94, Pl. 3 (figs. 4 a-c, 6-7), Pl. 4 (fig. 6)
1909 – *Goneplax* cfr. *sacci* Crema *in* Lőrenthey; p. 249, Pl. 1 (fig. 4 a-c, 6-7), Pl. 2 (fig. 6)
1929 – *Goneplax saccoi* Crema *in* Glaessner; p. 199
1948 – *Goneplax* cfr. *saccoi* Crema *in* Via Boada; p. 146, Pl. 1 (fig. 6)
1953 – *Goneplax gulderi* Bachmayer; p. 143, Pl. 9 (figs. 1-3)
1984 – *Goneplax gulderi* Bachmayer *in* Müller; p. 96, Pl. 93 (figs. 2-3)
1988 – *Goneplax* cfr. *saccoi* Crema *in* Solé & Via Boada; p. 34
1993 – *Goneplax gulderi* Bachmayer *in* Müller; p. 23, Text-fig. 11 K
1998 – *Goneplax gulderi* Bachmayer *in* Mayoral, Müller e Muñiz; p. 508, Text-fig. 2 (5)
1998 – *Goneplax gulderi* Bachmayer *in* Müller; p. 38
2004 – *Goneplax gulderi* Bachmayer *in* Garassino & De Angeli; p. 45
2006 – *Goneplax gulderi* Bachmayer *in* De Angeli & Garassino; p. 65

Stratigraphic range: Upper Miocene (Messinian); Pliocene *sensu lato*.
Type locality: Rio Popogna (Livorno), Monterotondo Marittimo (Grosseto).
Material and measurements: 11 complete specimens of which one in ventral view (male, CF-TCR2). GPDG 0085-0087 (Rio Popogna), GPDG 0088, CF-TCR2 (Monterotondo Marittimo), MSNM i27082-i27087 (Rio Popogna).

MSNM i27082 – lcxp: 15; wcxp: 15.5
MSNM i27083 – lcxp: 14.1; wcxp: 16.5
MSNM i27084 – lcxp: 15.8; wcxp: 18.7
MSNM i27085 – lcxp: 12.6; wcxp: 14.2
MSNM i27086 – lcxp: 10; wcxp: 12.2
MSNM i27087 – lcxp: 12; wcxp: 12.5
GPDG 0085 – lcxp: 16.5; wcxp: 18.3
GPDG 0086 – lcxp: 10.6; wcxp: 11.5

GPDG 0087 – wcxp: 13.9
GPDG 0088 – lcxp: 12; wcxp: 13.6
Cf-TCR2 – male ventral parts preserved.

Discussion. Müller (1993) recorded some specimens from the Neogene of Catalonia (Spain), discussing species of *Goneplax* from the Miocene-Pleistocene of Mediterranean area. The two fossil species from the Pliocene of Italy, *G. formosa* Ristori, 1868, and *G. meneghinii* Ristori, 1868, were considered by some authors as probably synonymous with the Recent Mediterranean species, *G. rhomboides* (Lin-

Fig. 18 – A) *Goneplax gulderi* Bachmayer, 1953, GPDG0085, dorsal view/norma dorsale (x 3.5). B) *Goneplax gulderi* Bachmayer, 1953, CF-TCR2, ventral view/norma ventrale (x 2).

naeus). In fact the carapace of *G. rhomboides* is extremely variable. Its fossil record from the Pliocene and Pleistocene of Italy was discussed by some authors (last reference Garassino & De Angeli, 2004). Müller (1993) distinguished *G. gulderi* Bachmayer, 1953, from *G. rhomboides* on the presence of the two well-marked transverse ridges on the carapace and the anterior margin where every orbit is as wide as the wide of the front; in *G. rhomboides* the orbits are more developed with respect to the width of the front.

Finally, Müller (1993) discussed the characters of the holotype of *G. sacci* Crema, 1895 (= *G. saccoi in* Glaessner, 1929) from the Miocene of Monte Capriolo (Bra – Cuneo). Even though the holotype of this species is not well preserved, it has the orbito-frontal margin very similar to that of *G. gulderi*. For this reason Müller (1993) considered *G. sacci* to be a probable synonym of *G. gulderi*.

The studied specimens confirm the observations made by Müller and therefore they are ascribed to *G. gulderi*. This species has been recorded from the Miocene (Badenian) of Austria and Hungary, from the Pliocene (Tortonian) of Spain, and from the Miocene-Pliocene of Italy (Piemonte, Toscana, Sardegna) (Crema, 1895; Lőrenthey, 1907, 1909; Bachmayer, 1953; Müller, 1984a, 1993, 1998; De Angeli & Garassino, 2006a).

Subsection Thoracotremata Guinot, 1977
Superfamily Grapsoidea MacLeay, 1838
Family Varunidae H. Milne-Edwards, 1853
Subfamily Asthenognathinae Stimpson, 1858
Genus *Asthenognathus* Stimpson, 1858

Type species: *Asthenognathus inaequipes* Stimpson, 1858.

Asthenognathus sp.
Fig. 19

Stratigraphic range: Pliocene *sensu lato*.
Type locality: Monterotondo Marittimo (Grosseto).
Material: one incomplete specimen, IGF 14637E
Desciption. Trapezoidal carapace, wider than long, convex in longitudinal section. Antero-lateral margins almost straight and aligned with the orbito-frontal part. Posterolateral reentrants well developed with slightly concave margin. The posterior margin is wide and slightly convex. Regions weakly marked. Metagastric region well marked by a deep posterior groove. Dorsal surface granulate.

Discussion. *Asthenognathus* Stimpson, 1858, includes four Recent species, *A. inaequipes* Stimpson, 1858, *A. hexagonum* Rathbun, 1909, *A. atlanticus* Monod, 1933, and "*Asthenognathus*" *gallardoi* Serène & Soh, 1976 (Ng *et al.*, 2008). The check list of the fossil species by De Angeli & Garassino (2006b) includes the following species: *A. cornishorum* Schweitzer & Feldmann, 1999 (Lower Miocene – United States), *A. globosa* (Karasawa, 1990) (= *Tritodynamia*) (Lower-Middle Miocene – Japan), *A. laverdensis* De Angeli & Garassino, 2006 (Lower Oligocene – Italy), *A. microspineus* Casadio, De Angeli, Feldmann, Garassino, Hetler, Parras & Schweitzer, 2004 (Middle Oligocene – Argentina), *A. urretae* Schweitzer & Feldmann, 2001 (Upper Oligocene – Argentina).

Fig. 19 – *Asthenognathus* sp., IGF 14637E (x 6).

The studied specimen shows morphological characters typical of *Asthenognatus* Stimpson, 1858. The lack of frontal and orbital parts do not allow a deep morphological description of this specimen. The studied specimen shows close affinities with *A. laverdensis* De Angeli & Garassino, 2006, from the Lower Oligocene of Laverda (Vicenza). However, this species has postero-lateral margins less convergent and dorsal surface smoother, with granulation limited only in the branchial regions.

Asthenognatus sp. represents the first report of this genus from the Miocene of Europe.

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Appendix

Updated list of the species of anomurans and brachyurans known to date from the Cenozoic of Tuscany (after Garassino & De Angeli, 2004; De Angeli & Garassino, 2006a).

Upper Miocene

Family Callianassidae Dana, 1852
Genus *Callianassa* Leach, 1814
Callianassa cfr. *C. subterranea* (Montagu, 1808) – Rio Popogna (Livorno)

Family Dorippidae MacLeay, 1838
Genus *Medorippe* Manning & Holthuis, 1981
Medorippe ampla Garassino, De Angeli, Gallo & Pasini, 2004 – Rio Popogna (Livorno)

Family Ethusidae Guinot, 1977
Genus *Ethusa* Roux, 1830
Ethusa popognensis n. sp. – Rio Popogna (Livorno)

Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia sp. (*in* Ristori, 1888) – San Benedetto in Val Benedetta (Livorno)

Family Goneplacidae MacLeay, 1838
Genus *Goneplax* Leach, 1814
Goneplax gulderi Bachmayer, 1953 – Rio Popogna (Livorno)

Family Potamonidae Ortmann, 1896
Genus *Potamon* Savigny, 1816
?*Potamon castellinense* (Szombathy, 1916) – Valle del Marmolaio (Livorno)

Pliocene *sensu lato*

Family Thalassinidae Latreille, 1831
Genus *Thalassina* Latreille, 1806
Thalassina sp. (*in* Ristori, 1891a) – Spicchio (Empoli – Firenze)

Family Paguridae Latreille, 1802
Genus *Pagurus* Fabricius, 1775
Pagurus squamosus Ristori, 1886 – Sarteano (Siena)

Family Diogenidae Ortmann, 1892
Genus Dardanus Paulson, 1875
Dardanus substriatus (A. Milne Edwards, 1861) – Volterra (Pisa)

Family Raninidae De Haan, 1839
Genus *Tribolocephalus* Ristori, 1886
Tribolocephalus laevis Ristori, 1886 – Orciano (Pisa)
Genus *Lysirude* Goeke, 1985
Lysirude paronae (Crema, 1895) – Cava I Sodi, Castelnuovo Berardenga-Scalo (Siena)
Genus *Raninoides* H. Milne Edwards, 1837
Raninoides pliocenicus n. sp. – Monterotondo Marittimo (Grosseto)

Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795
Calappa granulata (Linnaeus, 1758) – Presciano (Siena)
Calappa sp. (*in* Ristori, 1891a) – Orciano (Pisa)

Family Leucosiidae Samouelle, 1819
Genus *Ebalia* Leach, 1817
Ebalia fucinii Ristori, 1892 – Spicchio (Empoli – Firenze)
Genus *Palaeomyra* A. Milne Edwards, 1861
Palaeomyra bispinosa A. Milne Edwards, 1861 – La Strolla (Siena)

Family Portunidae Rafinesque, 1815
Genus *Portunus* Weber, 1795
Portunus edwardsi E. Sismonda, 1846 – Spicchio (Empoli – Firenze)
Portunus sp. (*in* Ristori, 1886) – Isola di Pianosa (Livorno)

Family Goneplacidae MacLeay, 1838
Genus *Chlinocephalus* Ristori, 1886
Chlinocephalus dimissiformis Ristori, 1886 – Mucigliani (Siena)
Genus *Goneplax* Leach, 1814
Goneplax rhomboides (Linnaeus, 1758) – Rapolano (Siena)
Goneplax gulderi Bachmayer, 1953 – Monterotondo Marittimo (Grosseto)
Genus *Simonellia* Vinassa de Regny, 1897
Simonellia quiricensis Vinassa de Regny, 1897 – San Quirico d'Orcia (Siena)

Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia cocchi Ristori, 1886 – Val d'Elsa (Empoli – Firenze); Montrappoli (Empoli – Firenze); Spicchio (Empoli – Firenze); Poggio all'Olio (Empoli – Firenze); Val d'Era (Pisa), Montebicchieri (Pisa), Torrita Val di Chiana (Siena); Pietrafitta (Siena); Terre Rosse (Siena).

Family Pilumnidae Samouelle, 1819
Genus *Pilumnus* Leach, 1815
Pilumnus ristorii new replacemnet name for *P. spinosus* Ristori, 1886 – Isola di Pianosa (Livorno)
Genus *Titanocarcinus* A. Milne Edwards, 1863
Titanocarcinus subovalis Ristori, 1896 – Monteroni d'Arbia (Siena)
Genus *Galenopsis* A. Milne Edwards, 1865
Galenopsis sp. (*in* Ristori, 1886) – Orciano (Pisa)

Family Xanthidae MacMeay, 1838
Genus *Monodaeus* Guinot, 1967
Monodaeus bortolottii Delle Cave, 1988 – Monterotondo Marittimo (Grosseto)

Family Varunidae H. Milne Edwards, 1858
Genus *Asthenognathus* Stimpson, 1858
Asthenognathus sp. – Monterotondo Marittimo (Grosseto)

Lower Pliocene

Family Callianissidae Dana, 1852
Genus *Callianassa* Leach, 1814
Callianassa chalmasii Brocchi, 1883 – Terre Rosse (Siena)

Family Diogenidae Ortmann, 1892
Genus *Dardanus* Paulson, 1875
Dardanus substriatus (A. Milne Edwards, 1861) – Terre Rosse (Siena), Balconevisi (San Miniato – Pisa)

Family Laomediidae Borradaile, 1903
Genus *Jaxea* Nardo, 1847
Jaxea cfr. *J. nocturna* Nardo, 1847 – Castelfiorentino (Firenze)

Family Calappidae H. Milne Edwards, 1837
Genus *Calappa* Weber, 1795
Calappa granulata (Linnaeus, 1758) – Terre Rosse (Siena)

Family Leucosiidae Samouelle, 1819
Genus *Ilia* Leach, 1817
Ilia pliocenica Ristori, 1891 – Ciuciano and Pietrafitta (Siena)
Genus *Ebalia* Leach, 1817
Ebalia cfr. *E. deshayesi* Lucas, 1846 – Poggio alla Staffa (Siena)

Family Portunidae Rafinesque, 1815
Genus *Liocarcinus* Stimpson, 1871
Liocarcinus sp. – Pietrafitta (Siena)

Family Eriphidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia cocchii Ristori, 1886 – Balconevisi (San Miniato – Pisa), Pietrafitta (Siena), Terre Rosse (Siena)

Family Pilumnidae Samouelle, 1819.
Genus *Pilumnus* Leach, 1815
Pilumnus ristorii new replacement name for *P. spinosus* Ristori, 1886 – Terre Rosse (Siena)

Upper Pliocene

Family Leucosiidae Samouelle, 1819
Genus *Ilia* Leach, 1817
Ilia pliocenica Ristori, 1891 – Spicchio (Empoli – Firenze)

Family Pilumnidae Samouelle, 1819
Genus *Titanocarcinus* A. Milne Edwards, 1863
Titanocarcinus edwardsi (E. Sismonda, 1846) – Orciano (Pisa)

Family Xanthidae MacLeay, 1838
Genus *Monodaeus* Guinot, 1967
Monodaeus bortolottii Delle Cave, 1988 – Botro dell'Alpino (Volterra – Pisa)

Plio-Pleistocene

Family Leucosiidae Samoulle, 1819
Genus *Ebalia* Leach, 1817
Ebalia cranchii Leach, 1817 – Parrana San Giusto (Livorno)
Ebalia fucinii Ristori, 1892 – Parrana San Giusto (Livorno)